

FOREWORD

Special Issue – Lidar Remote Sensing for Characterizing Forest Vegetation

Sorin C. Popescu and Ross F. Nelson

The Silvilaser 2009 conference held in College Station, Texas, USA, was the ninth conference in the Silvilaser series, which started in 2002 with the international workshop on using lidar (Light Detection and Ranging) for analyzing forest structure, held in Victoria, British Columbia, Canada. Following the Canadian workshop, subsequent forestry-lidar conferences took place in Australia, Sweden, Germany, USA, Japan, Finland, and the United Kingdom (UK). By the time this Silvilaser 2009 special issue of *PE&RS* is published, the 10th international conference will have been held in Freiburg, Germany, and planning will be ongoing for the 11th meeting to take place in Tasmania, Australia, in October 2011. Papers presented at the 2005 conference held in Blacksburg, Virginia, USA, were assembled in a special issue of *PE&RS* published in December 2006. Other special issues resulting from previous conferences were published in journals such as the *Canadian Journal of Remote Sensing* (2003), the *Scandinavian Journal of Forest Research* (2004), and Japan's *Journal of Forest Planning* (2008). Given the conference history and the much longer record of publications on lidar applications for estimating forest biophysical parameters, which dates back to the early 1980s, we may consider lidar an established remote sensing technology for characterizing forest canopy structure and estimating forest biophysical parameters. Randy Wynne, a professor at Virginia Tech and the final keynote speaker at Silvilaser 2009, made the case that it was time to push 30 years of research into operations, along the lines of what has already been done to good effect in the Scandinavian countries. In Randy's words, it's time to "Just do it!"

This special issue includes a selection of papers presented during the 2009 Silvilaser conference, which

consisted of eight sections as follows: (1) biomass and carbon stock estimates, (2) tree species and forest type classification, (3) data fusion and integration, (4, 5, and 6) forest inventory, (7) silvicultural and ecological applications, and (8) terrestrial lidar applications. Within the constraint limiting the number of papers that could be fitted into the special issue we attempted to select those papers that best represented these conference topics and sections, giving special consideration to studies using forestry lidar data collected from each of the three platforms -- terrestrial, airborne, and spaceborne. Reflecting the international participation and reach of the conference, the studies presented here took place in the USA, Canada, Taiwan, the UK, and China.

An atypical paper by Flewelling stands out from the usual technical papers published on lidar topics. Given the rising number of commercial lidar remote sensing applications in forest inventories, the goal of this paper is to increase awareness of patents awarded for data analysis methods. Patents are discussed in the context of a current controversy concerning methods patents, particularly software patents. A case can be made that these methods patents, which frequently build on the work of many, are being granted too liberally to a select few. Such assignments of "ownership" may, if the patents are enforced, discourage innovation and hinder scientific research.

Among the studies on airborne lidar published in this special issue, the paper by Gatzliolis presents a novel approach for improving the consistency of airborne lidar intensity measurements via range-based normalization. The utility of this approach was evaluated by examining classification results of broad forest cover types in

Oregon, USA, using observed and normalized intensity measurements.

Van Ewijk *et al.* characterized forest succession in Central Ontario, Canada, using airborne lidar-derived indices to discriminate between four forest stand development stages in mixed matured forests. Derived indices include statistical indices, Lorey's height, quadratic mean diameter-at-breast-height (dbh), canopy density indices, and an information theory-based complexity index.

Lin *et al.* present a novel morphological active contour algorithm for delineating individual tree crowns with airborne lidar data over mountainous forests in Taiwan. The algorithm consists in multiple steps and is capable of accommodating crowns with multiple high branches and overlapping crowns.

Two papers present methods for analyzing large-footprint, waveform lidar data, collected by the GLAS (Geoscience Laser Altimeter System) sensor on the ICESat mission (Ice, Cloud and land Elevation Satellite). The paper by Rosette *et al.* analyzes GLAS data to estimate forest parameters and to characterize terrain. They discuss the use of these satellite lidar observations as inputs to a computer-based mechanistic wind-risk model for forest management and assessment.

Zhang *et al.* reports on the extraction of new metrics from GLAS data to derive forest type information. They decomposed the waveform into Gaussian components for canopy and ground and related these canopy measurements to forest types, such as broad- and needle-leaved forests.

Two papers use terrestrial lidar data to estimate tree dimensions. The paper by Bucksch and Fleck presents a method for automatically extracting branch skeletons and branching hierarchy from terrestrial lidar data as the basis for modeling canopy structure. Analyzing the distance between laser hits in the point cloud and skeletons provides information on branch diameter.

Branch lengths and diameters showed good correlation to manual measurements.

Huang *et al.* describe an automatic approach to individual tree detection and measurement. They present a pilot study for extracting forest structural parameters, such as tree height, dbh, and tree location by processing a terrestrial lidar point cloud.

These seven papers represent a broad spectrum of lidar remote sensing applications for characterizing forest canopy structure and function and describe innovative studies using terrestrial, airborne, and spaceborne lidar data. We are pleased that the authors chose *PE&RS* as the publication outlet for their high-quality research work.

Lidar data from all three platforms, ground, air, and space, provide different perspectives on the forest three-dimensional structure, from below and above, and complement each other to increase our understanding of canopy structure. Given the ever increasing accessibility of lidar data, the technological progress of lidar sensors, data exchange standards, availability of data processing software, and future satellite lidar missions, we hope that this special issue provides timely information for a large audience with interests in remote sensing and applications in characterizing forest canopy structure and estimating forest biophysical parameters.

Special Issue Editors:

Sorin C. Popescu

Department of Ecosystem Science and Management
Texas A&M University
College Station, Texas, USA

Ross F. Nelson

NASA Goddard Space Flight Center
Greenbelt, Maryland, USA